



SMART HABITAT: ASSESSMENT OF COMMERCIAL-OFF-THE-SHELF “SMART” TECHNOLOGIES FOR APPLICATIONS IN LONG-DURATION EXPLORATION MISSION HABITATS



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Background

Proposed long-duration exploration missions highlight the need for increased crew autonomy and Earth-independent mission operations. It is thought that some of this autonomy may be achieved by incorporating intelligent (i.e., “smart”), highly autonomous technologies into the habitat, vehicle, and mission architecture to meet crew needs.

Objective

Identify the current state of Commercial Off the Shelf (COTS) smart-home technology devices and their applicability to space habitats and systems.

Methods

1. Identify Smart Home Devices

1. Review top-ranked devices
2. Analyze media device reviews
3. Develop device classifications

2. Normalize Product Functions

1. Conduct functional decomposition

“Samsung’s Family Hub™ refrigerator helps you connect to what’s most important: your family and home. Family Hub™ lets you see inside your refrigerator, manage your family’s calendars, stream music, see who’s at the front door and much more, all right from your fridge.” (Samsung, 2021)



“Provides quick overview function for stored items in the refrigerator”

2. Reorganize devices per spaceflight relevance

3. Identify Crew Needs

1. Review deep space mission profile literature
2. Review NASA reports for design recommendations

4. Align Norm. Functions with ISS Capabilities

1. Integrate Y1 deliverable to analyze capability needs
2. Review ISS current operations for relevant systems

5. Identify Gaps

1. Identify functional gaps
2. Identify technological limitations among COTS devices

Y1 - Habitability Attributes

Habitability

Human Health

- Physical Health
- Physiological Health
- Psychological Health
- Social Health

Human Performance

- Authority
- Control
- Mixed Agent Operations
 - Human Machine Teaming
 - Human Autonomy Teaming

Reviewed Smart Devices

Front Yard

- Path Lights
- Security Cameras
- Smart Lock
- Home Security System

Kitchen

- Convection Oven
- Smart Fridge

Bathroom

- Toilet
- Shower Controller
- Bathroom Scale

Garage

- Smart Garage Hub

Wearables

- Smart Watch

Living Room

- Smart Speaker
- Smart Display
- Light Bulbs
- Thermostat
- Smart Plug
- Home Security Camera
- Light Switch
- Vacuum

Bedroom

- Smart Bed
- Air Conditioner and Purifier
- Baby Monitor

Home Gym

- Stationary Bike
- Rowing Machine
- Treadmill
- Weightlifting Assistant

Back Yard

- Smart Sprinkler System

Function Analysis

Evaluation of normalized COTS smart home device functions for their potential to mitigate established habitability risks and considerations of current ISS operations and systems.

	Crew Exercise	Crew Ground Vehicle	N/A	Physical	Physiological	Social	Performance	Habitability
Weight	General Crew Operations (mission & vehicle)	Crew Ground Vehicle	N/A	Physical	Physiological	Social	Performance	Habitability
Air	Habitat	Temperature and Atmosphere Control	Crew Ground Vehicle	N/A	Physical	Physiological	Social	Habitability
Water	Habitat	Water Management	Crew Ground Vehicle	N/A	Physical	Physiological	Social	Habitability
Food	Habitat	Food Preparation	Crew Ground Vehicle	N/A	Physical	Physiological	Social	Habitability
Medical	Habitat	Medical	Crew Ground Vehicle	N/A	Physical	Physiological	Social	Habitability
Autos	Ground	Autos	Crew Ground Vehicle	N/A	Physical	Physiological	Social	Habitability
Smart Services	Prox	Prox	Crew Personal Hygiene	N/A	Physical	Physiological	Social	Habitability
Prox	Prox	Prox	Crew Food and Nutrition	N/A	Physical	Physiological	Social	Habitability
Prox	Prox	Prox	Crew Personal Hygiene	N/A	Physical	Physiological	Social	Habitability
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